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OBSERVATIONS ON PASTURE MANAGEMENT AND GRAZING

AG 502, January 1997

Darwin B. Nielsen

INTRODUCTION

While reading material on pasture management and livestock grazing, I kept a notebook of items that interested or surprised me. I was also interested in finding out why rotational grazing, especially short-time rotations (12 hours), were reported to give better results than continuous or longer time rotations (3-6 days). The reading material included:

- Smith, Burt; Pingsun Leung; and George Love. 1986. *Intensive Grazing Management: Forage, Animals, Men, Profits*. Kamuela, Hawaii: The Graziers Hui, P.O. Box 1994.
- Voisin, Andre. 1959. *Grass Productivity*. New York: Philosophical Library. Reprinted in 1988 by Island Press, Washington D.C.
- Murphy, Bill. 1994. *Greener Pastures on Your Side of the Fence*, Third edition. Colchester, Vermont: Arriba Publishing.

These notes are arranged by subject matter, not by author. They are not necessarily direct quotes from these books. Many of the topics were discussed by each of the authors.

Selection of the notes was based on an interest in pasture management, improving grazing systems, and grazing animal behavior as it might apply to Utah. This interest was stimulated as a result of research on pasture use and development and as a participant on the USU Pasture Committee.

Readers are encouraged to think about the concepts and how, or if, they are applicable to pastures in Utah. If there is a disagreement on some of the yield values or expected responses to management changes, this information should be made available and/or developed for Utah pastures.

REVIEW NOTES AND COMMENTS

Pasture plants must be allowed to grow after they have been grazed. The regrowth is powered by energy from photosynthesis occurring in the remaining leaves or from energy reserves if little or no leaf surface remains. Regrowth from plant reserves is slower than from having enough leaf surface for photosynthesis to function. Under most management systems, this argues for leaving enough leaf surface to get the faster regrowth. Overgrazing must be avoided; equally important, undergrazing must be avoided. A plant is **overgrazed** if it is grazed again before it has time to fully regrow its leaves and reestablish its roots. Undergrazed permanent pastures may have as many as ten or more grass species. In extremely overgrazed pastures, the only one present may be Kentucky bluegrass, at least in some parts of the U.S.

Proper levels of grazing by animals always cause a pasture to be a more complex mixture of plants than it would be without grazing. The plant composition of a pasture is very dynamic and changes very rapidly with the type of management applied. Thus, a newly seeded pasture but poorly managed degenerated in six years, despite the quality mixture sown. Proper management can transform a very old, degenerated pasture into an excellent pasture with a diversity of plant species in a relatively short time without reseeding. Poor quality pastures are the fault of man (management) not the grass. Renovation will provide only short-term relief if management does not change.

The following are common causes of poor quality pasture: (1) high water table or defective drainage, (2) poor soil nutritive elements, and (3) nonrational management which is usually

continuous grazing. Improving the first two will not solve the third.

An example of how management can change plant composition is taken from a pasture made up of Kentucky bluegrass and white clover:

- cut every week—white clover dominated 80% of the plants
- cut every 4 weeks—balance between grass and clover
- cut every 8 weeks—90% bluegrass, 10% clover
- cut every 12 weeks—99% bluegrass, 1% clover

The seed mix planted is not as important as management applied to the pasture. Competition for sunlight is the most important struggle among plants and has the greatest influence on an irrigated pasture's botanical composition and yield. When pasture plants grow too tall, they shade their own lower leaves plus they shade lower growing plants like some of the clovers. When this occurs, net forage production slows down and will reach a point where net forage production is zero. Net forage production remains high when pastures are kept below 6–8 inches tall. Pastures should not be so tall that shading is a problem or that the cow cannot be as efficient in harvesting the vegetation (6–8 inches). The pasture should be grazed down as uniformly as possible to the point where you get the forage but enough plant material (leaves) are left for fast recovery.

Weedy pastures result from poor management that gives weeds a competitive advantage for sunlight. Weedy plants with long wide leaves suppress shorter plants such as white clover by shading, especially if a pasture is understocked and grazed infrequently. But this growth habit gives no competitive advantage under frequent close grazing with high stocking density. Allowing selective grazing of shorter, more desirable plants, for example, by low-intensity continuous grazing, gives uneaten tall-growing broadleaf weeds a great competitive advantage for sunlight and seed production that allows them to dominate the pasture. Understocked lax continuous grazing is the main reason for the weedy messes typical of many local pastures, because it gives weeds the competitive advantage for sunlight over grasses and legumes.

Despite being less palatable, "weeds" have high feed values in immature growth stages. If these weeds are not eaten along with the clovers and grasses, the weeds are given a competitive advantage. If a pasture management system forces livestock to eat these weeds when they are immature, you take away their competitive advantage. If they get mature and rank, the most dependable, accurate, and easy to use method of weed control is mower, scythe, pruner, or shovel. Cut these weeds off as close to the soil surface as possible when they are in the bud stage, before flowering and seed set, so they do not reproduce. At this stage of growth, their food reserves are low, and removing their leaves weakens or kills them. Usually two or three cuttings will eliminate even the most persistent species.

A Vermont study reports the following average pasture plant growth rates measured in lbs dry matter (DM)/acre/day. The pasture mix was Kentucky bluegrass, orchard grass, and white clover.

April	33 lbs/acre/day
May	59 lbs/acre/day
June	57 lbs/acre/day
July	40 lbs/acre/day
August	40 lbs/acre/day
September	33 lbs/acre/day
October	12 lbs/acre/day

Seasonal growth variations occur in most parts of the U.S., which make balancing forage needs with forage availability more challenging for management.

A Wisconsin study showed these results from alternative harvesting methods.

Method of Harvest	% Lost	% Utilization
Continuous grazing	50	50
Rotational grazing	35	65
Strip grazing (12-hour rotation)	30	70
Hay	18	82
Silage	13	87
Green chop	8	92

The quality of pasture forage, for grazing or hay production, is affected by several factors, such as maturity, soil fertility, temperature, and moisture. When a grass plant begins to go to seed, nutrients are rapidly transferred from stem and leaves, in

effect, sacrificing them to get the energy and nutrients to grow seed. As a result, when seed heads appear, dead leaves accumulate rapidly and the overall digestibility and protein content declines sharply. When daily average temperature is above 86° F, the forage quality of grasses decline.

Kentucky bluegrass, orchard grass, bromegrass, timothy, and quackgrass produce as much or more forage as perennial ryegrass, unless you are willing to apply nitrogen fertilizer at more than 110 lbs/ac/yr to the ryegrass.

The only time a grass does not need rest is when it is dead (brown). When animals are turned into a large pasture and allowed to pick and choose when and what they want to eat, they tend to eat those plants they like the most. The other plants go ungrazed and mature, set seed, and multiply. The most desirable plants are grazed off every time they grow high enough to bite off. They never have enough time with enough leaf surface for photosynthesis to meet the needs of the plant (rest). Thus, within the same pasture there are plants that are overgrazed and others are not grazed at all. For example, 200 cows grazing a one-acre plot that has properly recovered from a previous grazing for 12 hours do not overgraze, but one cow grazing the same one-acre plot for 7 days or more does overgraze. A grazing animal sees forage plants as: (1) young green leaves and stems, (2) old green leaves, (3) dead or brown leaves, and (4) mature stems. With uncontrolled light stocking rates, the animal will select its diet in that order. The younger forage contains a lot of crude protein and also has high digestibility, all of which means good animal performance.

As pasture forage availability decreases, selectivity also decreases; forage not acceptable before now will be eaten. Animals continue to look for preferred plants, so they take longer to graze. They also take more bites, because their bites become smaller. Grazing animals walk as much as 2.5 miles per day, depending on forage availability. While grazing, cows move forward swinging their heads from side to side within an arc of 60–90 degrees, and take 30–90 bites per minute if the forage is the right length. Forage length is important in the way a cow grazes. If a cow is grazing very tall forage (10–14 inches), she eats the upper 2.5–3.0 inch layer or she

tears off a mouthful about 12 inches long. She cannot swallow such a large, long mass without chewing it first, and chewing it requires about 30 seconds per mouthful. In comparison, a cow grazing forage that is about 6 inches tall, can swallow 30 mouthfuls in 30 seconds. So animals grazing short forage can eat more during a day than when they graze long forage. For animal production, the goal is to get as much forage through the cow as possible.

Cows grazing a pasture of 4 inches height harvested the following amounts of forage:

1st 3 days cows harvested on average 150 lbs of fresh grass or 32 lbs DM
2nd 3 days cows harvested on average 90 lbs of fresh grass or 20 lbs DM
3rd 3 days cows harvested on average 44 lbs of fresh grass or 10 lbs DM

When these same cows grazed on the same pasture at 10 inches height; they harvested 68 lbs per day of fresh grass or 16.5 lbs of DM.

Height of the forage is not necessarily a good measure of the total amount of forage available. For example, forage present on a 4" high pasture is 4,500 lbs/acre, if it is allowed to grow to 10" height, the forage present is 5,000 lbs/acre. The height of the forage increased 2.5 times but it only produces 11% more total fresh forage.

A cow harvests the maximum quantity on a pasture of 6 inches height or shorter, not on a pasture where the forage is allowed to grow taller.

The reported grazing time during a 24-hour period never exceeded 8 hours per day based on the books reviewed. Cattle traveled about 2.5 miles in a day. The grazing time in a day remains the same whether the cow is grazing tender, lush forage or dry, rank, scattered plants over a wide area. A study reported in the *Journal of Range Management* found longer grazing times with continuous grazing (10.3 hours/day) than with rotational grazing (7.9 hours/day).

Heredity produces grazers with long harvesting times and grazers with short grazing times. The cattle with long grazing times were capable of harvesting 63% more forage than those with short grazing times. However, cows have a general tendency to graze, ruminate, or rest together—an aggressive (long harvesting time)

grazer will follow the herd and give up its individual behavior. The solution is to keep all long-grazing cattle in the same herd. A factor in selecting breeding animals might be those that had long-grazing times. Cows do not try to compensate for reduced forage availability by grazing more hours per day. (They will not put in any overtime.) Increasing the grazing area does not lead the cow to make any more effort to harvest a greater amount of forage even if she is barely meeting her maintenance requirements.

Grazing time in cattle almost never lasts more than 8 hours per 24-hour period. *Grazing time is the same regardless of pasture quality or the amount of forage available.* About 60% of cattle grazing occurs in daylight, and 40% at night. As it gets hotter in the summer, more grazing occurs at night. Cows ruminate about 8–10 hours per day and lay down about 12 hours per day.

The materials reviewed for this report were quite strong in the statements made about the grazing behavior of cattle relative to time grazing during a 24-hour period, regardless of forage quantity or quality. Since other studies have reported different results, more research data and/or observations from pasture-based livestock operators should be considered in making management decisions.

On average, a mature cow will consume about 2.5% of its live weight in DM per day. This is equivalent to 12.5% of its live weight in fresh green material, due to the moisture content (80% water) in the forage. A 1,000 lb cow will eat 25 lbs dry matter per day or 125 lbs. of fresh green forage per day.

Because of their mouth structure, cows cannot graze closer than ½ inch from the soil surface. Horses can grip plants and cut them off closer to the ground than cattle. Horses graze very selectively, making it difficult to get a good botanical composition in a pasture grazed only by horses. A horse pasture should be mowed at least twice per grazing season to clip the forage horses will not eat and keep the pasture in good condition for subsequent grazing.

Animals will generally avoid grazing around dung patches made by their own species but will graze close to dung of another species. Cattle will graze close to dung from horses and horses will graze close to cow dung pats. Horses could be used to graze grass that would get tall and rank around cow

pats. Odor causes this avoidance phenomenon and it takes 2–3 weeks for the odor to leave. By the time the odor has gone, the plants are ranker and less palatable than forages in other areas of the pasture, so they remain ungrazed unless animals are forced to eat them.

Most grazed pastures (horses, cattle, or sheep) will need to be mowed once or twice during the grazing season. Some of the advantages of clipping pastures are to:

- (1) remove rank plants and encourage new growth,
- (2) reduce incidence of eye irritation, and
- (3) set back weed growth.

It is also a good practice to drag (harrow) the pasture after clipping and at other times, if needed, to (1) spread manure piles, (2) destroy internal parasite eggs, and (3) reduce selective grazing.

Beef cattle defecate about 12 times per day and urinate about 9 times per day. A beef cow defecates about 50 lbs per day (since she only consumes 35–40 lbs per day of forage (dry matter), there must be lot of water in it). This amounts to 9,000 lbs during a 180-day grazing period. This would result in a cover of 1,260 square feet per season if there was no overlap or 35 head could cover an acre in a grazing season. Forage around dung pats is greener and grows faster because: (1) of the fertilizer effects, mainly N, and (2) the texture and color of a dung pat makes it warmer during the day and into the night plus the heat from decomposition. This would cause plants to have a higher growth rate, especially during the cooler parts of the growing season. Cattle do not avoid urine spots while grazing. About 70% of the nitrogen ingested by cattle is excreted in the urine. A cow's urine patches could cover 27 sq ft per day, or 4,860 sq ft in a 180-day grazing season.

Grazing animals impact a pasture in several ways such as defoliation (removal of plants leaves), excretion of manure (dung and urine) by these animals, treading action of animals' hooves on plants and soil, and dispersion of seeds. Seeds are dispersed as they attach to hooves, hides, and wool and are scattered around the pasture. Seeds can also be carried around in digestive tracts of livestock, then dropped in manure. Passage of undigested

seeds through ruminants takes from 12 hours to about 6 days, depending on the animal. About 10% of the seed that is eaten passes unharmed through animals.

The statements that follow are given as management tips:

- (1) Never rotate cattle onto a paddock with a significant amount of clover when the morning dew is still on the grass or in the glaring heat of the afternoon, for some reason these conditions are conducive to bloat.
- (2) If crude protein content of the feed drops below 7%, the animal does not have enough protein to maintain itself.
- (3) Only green leaves put weight on livestock.
- (4) As stocking density increases, differences in relative acceptability among plants practically disappear.
- (5) If an animal stops gaining, it costs two to three times as much to get them started again.
- (6) If you have low-quality forages go for pounds per acre rather than pounds per animal.
- (7) Cows prefer to graze plant communities in dry, as opposed to wet, places.

On open range, cattle may only come to water once a day or even once every two days in cool weather. However, once at water, they will remain for several hours and drink several times. Animals require more supplemental sodium (salt) when the forage has gone to seed or dried up than when it is green. The sodium in salt helps animals control body temperature, so it is more important than shade.

Percentage utilization is calculated by taking the amount of forage left when animals leave divided by the amount that was available before animals were turned into the pasture. This measure is an important management consideration with the following suggested values:

- 50% take half leave half for continuous grazing
- 55% for long-term rotations—one month or longer
- 60% for short-term rotations—one week long
- 70% for daily shifts
- 75% for intensive strip grazing—12 hours—take 75% leave 25%

VOISIN'S LAWS OF RATIONAL GRAZING

First Law: Before a pasture, sheared with the animals teeth, can achieve its maximum productivity, sufficient interval must have elapsed between two successive shearings to allow the grass:

- (a) to accumulate in its roots the reserves necessary for a vigorous spurt of re-growth;
- (b) to produce a high daily yield per acre.

In the May–June period with 18 days rest the maximum **daily** re-growth of grass is 240 lbs per acre compared to 71 lbs per acre with a rest period of 6 days. A rest period of 6–8 days is usual with continuous grazing.

Second Law: The total grazing period on one paddock should be sufficiently short so that grass grazed the first day of occupancy is not grazed again during that rotation.

Third Law: The animals with the greatest nutritional requirements must be helped to harvest the greatest quantity of grass of the best possible quality.

Fourth Law: To get reasonable production (gain, milk) the animal should stay no longer than three days on the same paddock. Yields will be at their maximum if animals are on the paddock 12–24 hours.

It is by satisfying as far as possible the demands of the cow and the grass that one arrives at rational grazing.

Continuous grazing will utilize between 40% to 50% of the standing crop, twice daily shifts with long strips will utilize 90% of the standing crop.

The period of rest will be equal to the number of paddocks at rest, multiplied by the mean number of days of stay.

Example (1):

20 paddocks—period of stay 2 days,
1 group of cattle

No. of pastures at rest = $20 - 1 = 19$

Rest period = $(20 - 1) \times 2 = 38$ days

Example (2):

20 paddocks—period of stay 2 days;
two groups of cattle
No. of pastures at rest = $20-2 = 18$
Rest period = $(20-2) \times 2 = 36$

Example (3):

20 paddocks—period of stay 2 days;
three groups of cattle
No. of pastures at rest = $20-3 = 17$
Rest period = $(20-3) \times 2 = 34$

A farmer wants to have the minimum number of paddocks to reduce the cost of fencing and to simplify the program. This thinking may lead to problems. Maximum period of stay (grazing period) is 3 days—unless the farmer is willing to give up animal performance (milk production or lbs gain/day). A grazing period of 6 days is on the margin of where the grass will be grazed twice in the same rotation.

A comparison of production with continuous grazing versus rational grazing is given in the following example. In May–June, pasture production was 71 lbs/acre/day with continuous grazing compared to 237 lbs/acre/day with the optimum rest period of 18 days between grazings. In August–September, pasture production was 36 lbs/acre/day with continuous grazing compared to 119 lbs/acre/day with the optimum rest period of 36 days between grazings. Pastures with long rest periods between grazing (25–40 days as season progresses) produced 160% as much forage as when a short rest period system (10–30 days) was used.

The major benefits from a large number of paddocks (16 or more), thus short grazing periods, is nutrition and the stimulation of forage intake that is caused by frequent shifts to fresh feed. Shifting animals to a new pasture (paddock) increases forage intake, even if the shift occurs after animals have just finished a grazing period. Animals respond with a “greedy” social attitude which can increase forage intake by as much as 20%. On a 3-day rotation, this stimulation occurs once every 3 days. If animals are rotated every 12 hours, this stimulation occurs six times in 3 days.

A large number of animals in a small area for a short period of time has four other advantages: (1) large quantities of manure and urine are deposited

in a short period of time; (2) cow pies are broken up and scattered; (3) dung beetles are more active because of large amounts of manure in a small area; and (4) trampling, compacting, and plant damage are reduced because of this short period.

Rational grazing has the potential to triple the yield over continuous grazing. A pasture grazed at 6" height under the rational system produced 2,100–2,400 lbs DM per acre. When the pasture was grazed continuously through the season and the only forage that was grazed was 1"–2" height, it produced 1,000–1,200 lbs DM per acre.

The “time factor” (interval of rest between grazings) is first reported as being important in the early 1950s. Ninety percent of the failures of rotational grazing systems can be traced to the “time factor” as of 1988. When growth rate slows down, the grazing cycle slows down; when the growth rate speeds up, the grazing cycle speeds up. The importance of giving the plant time to replenish its energy reserves cannot be over emphasized. The basic reason for rotational grazing is to give the plants a rest while the animals are shifted out. Grazing systems that are designed with relatively short rest periods between grazings run out of forage in the mid to late grazing season. A reduction in the number of stock is of no avail to solve this problem. When grazing begins in the spring you can graze some paddocks a bit early to prevent plants getting too tall later in the rotation. Start when plants are 2"–3" tall (1,400–1,600 lbs DM/acre). Paddocks need not be equal in area but need to be equal in the quantities of forage.

Good pasture management should have a goal of keeping the nutrients excreted by grazing animals recycled as efficiently as possible. Remember, 100 cows grazing a 1-acre plot for 24 hrs. apply about 39 lbs of N, 16 lbs of P, and 32 lbs of K in their manure and urine per acre per day. Grazing animals remove nutrients from plants by eating their leaves and stems, which results in movement of nutrients from the plants back to the soil. This is an essential part of rapid nutrient cycling in a pasture environment. Uneaten plants slow nutrient cycling because nutrients are not available until the plant material breaks down through weathering or biological decomposition on the soil surface. Proper grazing reduces the amount

of uneaten plant material and, through hoof action, helps break down uneaten material so it decomposes faster, thereby speeding up the nutrient cycle.

Legumes are absolutely essential to have in your pasture to obtain the excellent quality forage needed to achieve high livestock production levels at low cost. The nitrogen fixed by legumes ultimately becomes available to associated grasses through urine and manure excreted by grazing livestock and through microbial breakdown of legume nodules, roots, and shoots in the soil. Legumes should make up about 30% of the plants in a pasture. White clover, red clover, and alfalfa can cause bloat, while birdsfoot trefoil, cicer milkvetch, and sanfoin are all nonbloating legumes. Legumes get about 75% of their total nitrogen requirements for growth from their ability to “fix” nitrogen.

More than 85% of pasture plant roots are concentrated in the top 2–3 inches of soil, so this area of the soil profile is most important in plant nutrition. A seasonal pasture yield of 5.0 tons of dry forage per acre contains about 4.0% nitrogen, which means that 400 lbs of N per acre had to be available to the plants. If the other nitrogen requirements (root development) and losses are considered more than 550 lbs of nitrogen had to be available during the growing season. In the U.S., rain and snow will add an average of 5–10 lbs of N per acre per year. More than 70% of the nitrogen, 60% of the phosphorous, and 80% of the potassium in feed can be present in manure (includes urine) for recycling onto pastures.

In order for plants to utilize and vigorously respond to nitrogen they must have sufficient root reserves. In the spring, these reserves have to be carried over from the preceding fall. Grasses grazed continuously during the summer will not have reserves enough to respond to a late season stimulus from nitrogen. Nitrogen application (216 lbs./acre) applied in the second half of the growing season produced more total forage than when the nitrogen was applied at the beginning of the season. The late season application also produced more forage in the late season when it was needed most to even out the production over the season. Nitrogen fertilizer can be used to lengthen the grazing season. You can graze earlier in the season and continue later in the season. Generally two weeks earlier and two weeks later. Applications of N to a pasture favors grasses over

clover. The grasses use it to produce a large amount of top growth that shades the clover plants. Phosphorus applied to most pastures in the Intermountain West give clovers a boost, making them more competitive with the grasses.

Most of the nutrients remain in a well-managed, grazed pasture, cycling continuously through the environment. So usually all that is needed in any pasture are adequate levels of nutrients to start with. However, this would depend on what nutrients are imported to and exported from the pasture.

If a plant has adequate amounts of soil nutrients, the proportion of the plant above ground increases relative to the root system, because the plant does not need to develop such an extensive root system to find and uptake these nutrients. Grazing causes the plant root mass to shrink and grow as the shoot is harvested and regrows. As roots regrow, more carbon is removed from the atmosphere, thereby helping to lower atmospheric carbon dioxide levels and lessen the probability of earth warming. Some experts say that each acre of cropland converted to pasture could remove 43,000 lbs of carbon dioxide from the atmosphere and store it in the soil.

When all or most of a plant's leaves are removed, its root growth stops and the plant uses its carbohydrate reserves in roots and stubble to regrow new leaves and stems. It usually takes 2–7 days after grazing for enough leaf growth to meet its energy needs. Alfalfa requires about 14–21 days to form enough leaf surface to provide the needed energy for the plant to stop using its reserves.

Reasonable amounts of defoliation causes more branching and lower growth forms of plants. This results in tighter sod, better soil cover to prevent erosion, and higher yields of nutritious forage. Plants having more branches or stolons and less shading tend to have more flowers and produce more seed.

Grass hay must be harvested before seed heads form if quality of the hay is important. Harvest grasses at the boot stage, when the seed head is just about ready to emerge, for high quality hay. In one case, the crude protein of a grass dropped from 19% to 16.5% in one week as the grass matured. There is a trade-off between quality and quantity, which must be considered by the manager.

The following points and/or ideas are provided for consideration:

- (1) Leaching of plant nutrients is important. One inch of rain on dead leaves may remove 50% of the soluble carbohydrates and reduce the overall feed value by 30%. A light drizzle removes more nutrients than does a heavy rain.
- (2) Feeding pregnant heifers in the evening, rather than in the morning, has been found to result in 17% more daytime births. The removal of calves from mothers 24 to 48 hours prior to turning the bulls in is of questionable value in pregnancy rates or calving interval.
- (3) Salt stimulates a cow's appetite for food.
- (4) The salt requirement for cattle is 3-5 lbs/animal/month.
- (5) Milk production drops about 2 lbs per day per mile a cow is forced to walk to the barn, for water, etc.
- (6) Cows hear high frequency noises much better than humans; that's why the cracking of whips can drive them up a wall.
- (7) Dominant cattle are usually not the leaders of a herd of cattle being moved. They take a position towards the front but not as leaders. Split the herd just behind these dominant cattle and drive them, the subordinates in the "drag" will follow without as much effort to drive them.
- (8) It has been reported that applying as little as 40 lbs of urea per acre can reduce earthworm numbers in half. A healthy population of earthworms are desirable because they break down materials and make them available for plant use. A German study found that the weight of earthworms under the soil of a pasture was twice the weight of livestock grazing the surface.

- (9) One of the benefits reported for liquid manuring was the control of Canadian thistle. Probably because of the salts contained in manure, thistles covered by applying liquid manure dry out, die, and disappear.
- (10) Fence (electric) wire placement for cattle and horses.
 - 1-wire 33" height
 - 2-wire 20" and 36" height
 - 3-wire 16", 28", and 40" height
- (11) Amount of fence required for a one-acre field:
 - 70 yds x 69 yds = 278 yds
 - 55 yds x 88 yds = 286 yds
 - 40 yds x 121 yds = 322 yds
 - 20 yds x 242 yds = 524 yds
 - 10 yds x 484 yds = 988 yds

ANIMAL UNIT CONVERSION SYSTEM

Body Weight (lbs)	Body Weight Raised to .75 Power	Animal Unit Equivalent
1,000	$1,000^{.75} = 177.8$	$177.8/177.8 = 1.0$
150	$150^{.75} = 42.8$	$42.8/177.8 = .24$
400	$400^{.75} = 89.4$	$89.4/177.8 = .50$
500	$500^{.75} = 105.7$	$105.7/177.8 = .59$
650	$650^{.75} = 128.7$	$128.7/177.8 = .72$
800	$800^{.75} = 150.4$	$150.4/177.8 = .84$
1,100	$1,100^{.75} = 191.0$	$191.0/177.8 = 1.07$

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